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BOTANICAL
GARDENA STATISTICAL METHOD FOR COMPARING THE
AGE OF DIFFERENT FLORAS

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It is a well-known principle of phytogeography that when an area devoid of vegetation and true soil, such as one which has recently been covered with water or ice for a long period, is first invaded by plants, the lower forms tend to predominate at first, and gradually pave the way for higher ones.* It is also generally conceded by botanists that monocotyledonous plants as a class are of lower rank than dicotyledons. Putting these two conceptions together, a method is at once suggested for determining roughly the age of a given flora, for a study of the relative proportion of monocotyledons and dicotyledons in any essentially homogeneous region ought to throw some light on the length of time that that region has been continuously occupied by vegetation.† The application of this method, crude as it may seem, gives some remarkably consistent results for regions believed to be of the same age geologically.

The glaciated region of the northern states is believed to have been entirely devoid of vegetation — at least as far as flowering plants are concerned — as late as fifteen or twenty thousand years ago; and most of the coastal plain of the southeastern states was probably submerged beneath the sea at about the same time.

* Prof. N. S. Shaler's very interesting paper on "The origin and nature of soils" (12th Ann. Rep. U. S. Geol. Surv., pp. 213 et seq.) should be consulted in this connection.

† This method is so simple that it can hardly be claimed as original, but it probably has not been applied to so many different parts of Eastern North America before. MacMillan came very near it in some of the statistical discussions in his "Metaspermæ of the Minnesota Valley" in 1892, but did not use it for comparison in this way.

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The floras of these two regions ought therefore to be among the most recent in existence. The southern Alleghanies and adjacent Piedmont region, on the other hand, have probably been continuously covered with vegetation ever since the Palaeozoic period, a time long antedating the appearance of any species of plants now living.

Below are given the proportions of monocotyledons to the total number of species of angiosperms in several parts of temperate Eastern North America whose floras have been written up with some care. After the name of each region are given the author and date of the flora from which the statistics were derived, and then the percentage of monocotyledons. It is of course only native plants that are of significance in this connection, but in some local floras no distinction is made between native and introduced species. So two columns of percentages are given, one for native species alone and the other for native and introduced.

The regions in the first list are wholly included in the glaciated region.

	Native	Native and Introduced
Maine (Fernald, 1892),		29
Vermont (Brainerd, Jones & Eggleston, 1900),	35.7	32.3
Essex County, Massachusetts (Robinson, 1880),		30.6
Middlesex County, Massachusetts (Dame & Collins, 1888),	35	30.6
Worcester County, Massachusetts (Jackson, 1894),		28.4
Amherst and vicinity (Tuckerman & Frost, 1875),	34.3	32.2
Connecticut (Bishop, 1901),		30
New Haven and vicinity (Berzelius catalogue, 1878),		29.2
Southington, Connecticut (Bissell & Andrews, 1902),	31	28
Cayuga Lake basin, New York (Dudley, 1886),		31.8
Monroe County, New York (Beckwith & Macauley, 1896),		30
Michigan (Beal, 1904),		30
Minnesota Valley (MacMillan, 1892),		28.4

New Jersey is about half coastal plain and the remainder of the state mostly glaciated. The corresponding figures for it (Britton, 1889) are 33.2 per cent. and 29.3 per cent.

The following areas lie wholly in the coastal plain :

	Native	Native and Introduced
Dismal Swamp and vicinity (Kearney, 1901),		30.9
Vicinity of Wilmington, N. C. (Wood & McCarthy, 1887),		28.6
Okefinokee Swamp and vicinity (Harper, ined.),		29.3

	Native	Native and Introduced
Allamaha Grit region of Georgia (Harper, 1906),	30	29.6
Florida (Hitchcock, 1899-1901),		28.4
Lee County, Florida (Hitchcock, 1902),		34.9
Plaquemines Parish, Louisiana (Langlois, 1881),		29.4
Lower Louisiana (Langlois, 1887),		28.5

It is rather unfortunate that local floras of parts of Eastern North America which include neither coastal plain nor glacial drift are not numerous. There is not yet even one for the southern Alleghanies from which any such calculations as these can be made. The following regions, however, include none of the Pleistocene areas above mentioned, or such a small proportion of them that it does not seriously impair the results.

	Native	Native and Introduced
Chester County, Pennsylvania (Darlington, 1853),	27	25.7
West Virginia (Millsbaugh, 1892),	21.8	20.6
West Virginia (Millsbaugh & Nuttall, 1896),		20.7
Tennessee (Gattinger, 1901)		24
Jackson County, Missouri (Mackenzie & Bush, 1902),		27
Athens and vicinity, Middle Georgia (Harper, 1900),	19.8	
Metamorphic region of Alabama (Earle, 1902),	26.7	25.6

In this list some of the percentages which are higher than the averages are capable of explanation. In Chester County, Pennsylvania, Muhlenberg's work on the grasses and sedges of the vicinity early in the century may have had something to do with the relatively high proportion of monocotyledons recorded. And in Earle's Flora of the Metamorphic Region of Alabama the southern boundary of the region is so loosely drawn (as the author admits in his preface) that a considerable coastal plain element is included.

The discrepancies between different figures in any one of these three lists may be due as much to personal equation as anything else, and it is remarkable that they are not greater. But with all sources of error included, the above statistics nevertheless seem to show that no glaciated or coastal plain area contains less than 30 per cent. of native monocotyledons, while none of the older regions has more than 27 per cent. If authors of future local floras will bear this method in mind and tabulate their species

accordingly we can ultimately determine how universally this relation holds good. It is interesting to note that in every case above where both figures are given there is a smaller proportion of monocotyledons among the introduced species than among the natives.

In applying this statistical method to other regions some cautions must of course be observed. For instance, extreme accuracy could not be expected where the number of species involved is much less than a thousand. And it would hardly be advisable to compare areas too widely separated, for the proportion of monocotyledons may vary considerably on different continents, or in different climatic zones.

A similar method applied to different habitats in the same region indicates roughly not the age of the flora of each habitat but its affinities with other regions and its place in the order of succession. In the Altamaha Grit region of Georgia for instance, the flora of river-bluffs, which represent the extreme of mesophytic conditions for that region and have about 90 per cent. of species in common with the Piedmont region and mountains, contains only 13 per cent. of monocotyledons. On the other hand the moist pine-barrens have only about 20 per cent. of their species ranging beyond the limits of the coastal plain, and 44 per cent. of monocotyledons.

Some other kinds of statistics may perhaps hereafter be found equally useful for the same purposes. For example, the ratio of Gamopetalæ to Polypetalæ, of grasses to sedges, or of woody plants to herbs. In the glaciated region and coastal plain, sedges seem usually to outnumber the grasses, while the reverse is true in most other parts of the world; and woody plants tend to be more numerous in old regions than in new, if the climatic conditions are not too different.